Travis County FY2014
Jollyville Plateau Salamander (*Eurycea tonkawae*)
Monitoring Report

Photo: Jollyville Plateau salamander - Piers Hendrie, Spring 2008

Travis County
Department of Transportation and Natural Resources
Natural Resources and Environmental Quality Division

October 1, 2013 – September 30, 2014

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Background

On May 2, 1996, the City of Austin and Travis County were jointly issued a U.S. Fish and Wildlife Service (USFWS) regional permit referred to as the Balcones Canyonlands Conservation Plan (BCCP). This permit allows “incidental take” of eight locally occurring endangered species in compliance with Section 10(a) 1(b) of the Endangered Species Act (U. S. Fish and Wildlife Service 1996a). The thirty-year permit covers approximately 561,000 acres in western Travis County, Texas identified in the Habitat Conservation Plan and Final Environmental Impact Statement (HCP) (U. S. Fish and Wildlife Service 1996b). The permit also covers incidental take of 27 species of concern should any become listed as threatened or endangered during the life of the permit.

Under the terms of the permit, the City of Austin and Travis County established the Balcones Canyonlands Preserve (BCP) to set aside and manage a minimum of 30,428 acres of habitat for two endangered bird species, the golden-cheeked warbler (*Setophaga chrysoparia*) and black-capped vireo (*Vireo atricapilla*), and six endangered karst species. The permit holders also agreed to manage twenty-seven species of concern that include populations of two rare plants, Texabama croton (*Croton alabamensis* var. *texensis*) and canyon mock-orange (*Philadelphus ernestii*), and a suite of unique invertebrates located in a total of 62 karst features.

The Jollyville Plateau salamander (JPS) (*Eurycea tonkawae*) occurs within the BCP and the overall management of Travis County preserve lands benefits the conservation of this species. Although the BCCP 10(a) permit does not cover “take” of this species or require mitigation, the BCCP partners have pledged to protect the species wherever it is located within the BCP.

On September 19, 2013, the U.S. Fish and Wildlife Service listed the JPS as threatened (U. S. Fish and Wildlife Service 2012) under the Endangered Species Act and designated thirty-two units of critical habitat (total 4,331 acres) in portions of Travis and Williamson Counties (Figure 1). The most significant threat is degradation of aquatic habitats, primarily in the form of reduced water quality and alteration of natural flow regimes (USFWS 2013). The degradation is a result of rapid human population growth and urbanization within the small range of the JPS. About half of the total area within stream catchments within the JPS range has been developed. In areas with the largest residential development, there has been decline in relative abundance of JPS.

Urbanization has a strong negative effect on density of JPS across its range (Bendik et al. 2014).

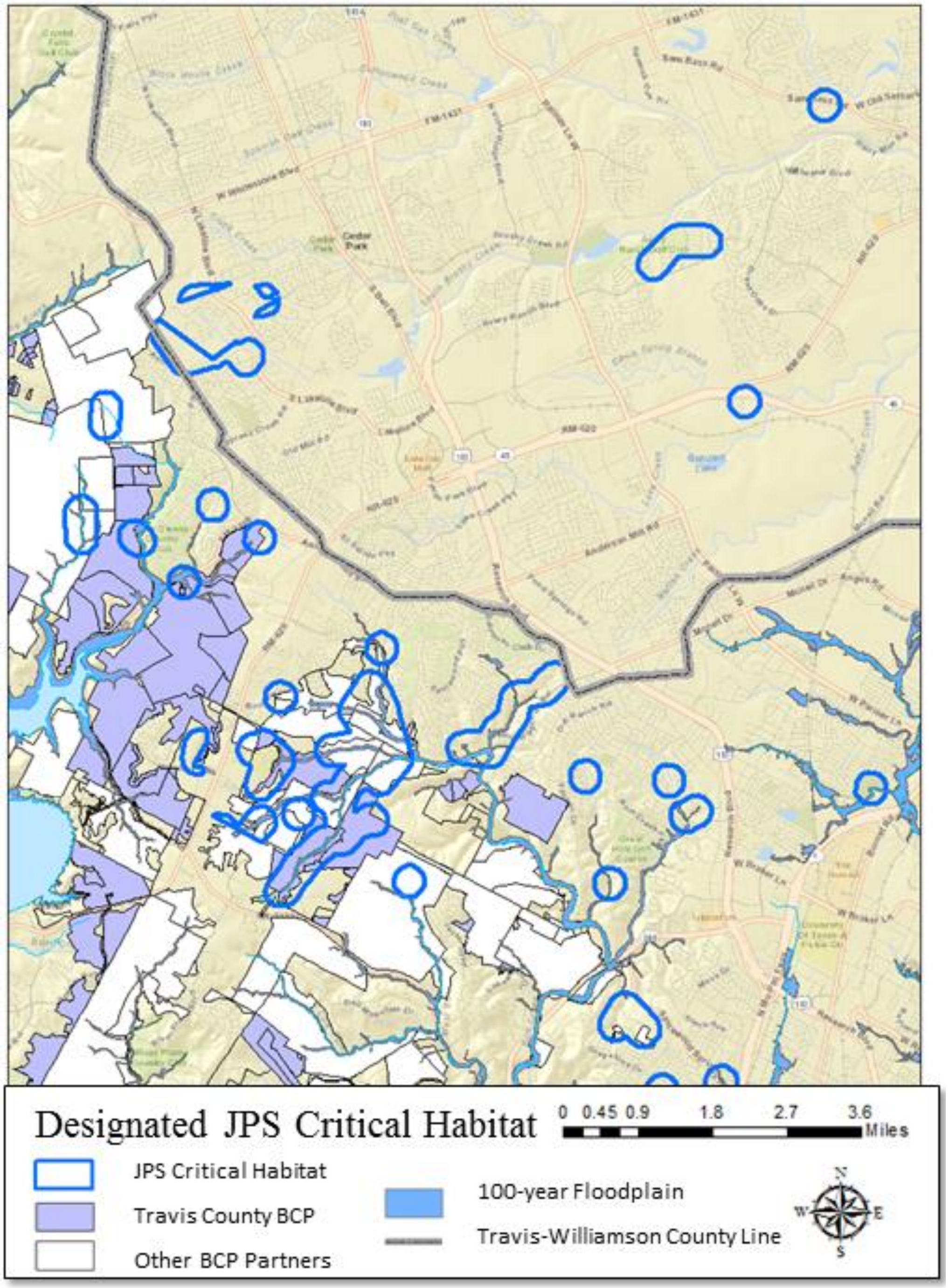

Figure 1. Critical Habitat Units designated for the Jollyville Plateau salamander in northwestern Travis and southern Williamson Counties. Surface critical habitat includes the spring outlet up to the high water line and 164-feet (50 m) downstream. Subsurface critical habitat includes a 984-foot (300 m) radius surrounding each spring.

Life History of JPS

JPS is an aquatic salamander that is endemic to surface and subsurface groundwater dominated habitats in northwestern Travis and southern Williamson counties. It is entirely aquatic; it does not transform into a terrestrial form (neotenic) and retains its feathery gills (perennibrachiate) throughout its life. It is a member of the Plethodontidae, a large family in the order Caudata that is characterized by the absence of lungs. JPS respires through gills and permeable skin.

JPS found on the surface have well developed eyes, a wide head, and dark greenish brown body. Cave-dwelling salamanders can have reduced eyes, a flattened head, and loss of color (Chippendale *et al.* 2000). Chippendale suggests that there are two lineages, the taxonomic split corresponding to major geologic and topographic features. The "plateau" clade occupies Bull, Walnut, Shoal, Brushy, South Brushy, and southeast Lake Travis watersheds. The "peripheral" clade is found in the Buttercup and north Lake Travis watersheds.

The eggs of the JPS are rarely found on the surface, so it is likely that they are deposited underground (O'Donnell *et al.* 2005). The skin on the ventral side of the body is translucent so that eggs are visible. Some female JPS have been observed with eggs.

It appears from the presence of juveniles on the surface in all seasons that they reproduce year round (Bendik 2011a, Hillis et al 2001). However, juvenile abundance often increases in the spring and summer suggesting higher reproduction in the winter and early spring (Bowles et a. 2006). At hatching, JPS are about 15 mm total length and reach reproductive maturity around 45-50 mm total length within six months to a year.

Their diet consists of small invertebrates, including fly larvae, amhipods, ostracods, copepods, water mites, snails aquatic beetles, and damselfly, caddisfly, mayfly, and stonefly larvae. (COA 2001, Bendik 2011b pers. comm, USFWS *in press*). If flatworms are present in JPS habitat, they may be part of the diet. Flatworms are a primary food source of the Barton Springs salamander (Gillespie 2013). Underground, it is likely their diet is more restricted to stygobitic invertebrates like amphipods and isopods.

Predators of JPS may include centrarchid fish (sunfish and bass), crayfish, and large insects such as dragonfly nymphs and giant waterbugs (Bowles *et al.* 2006, Cole 1995).

The JPS inhabits groundwater-associated habitats, both surface and subsurface. On the surface, they can be found near spring outlets, along spring-fed streams, and in small hillside seeps. Underground, they inhabit the groundwater in the interstitial spaces and voids, subterranean streams, and wet caves. There are 106 known JPS surface sites in northwestern Travis and southern Williamson Counties. Their range includes the following nine watersheds: Brushy, Bull, Buttercup, Cypress, Lake, Long Hollow, Shoal, Walnut, and West Bull.

The narrow distribution of JPS has been explained by certain habitat requirements, such as reliability of flow, minimal substrate siltation and calcium carbonate deposition (Tupa and Davis 1976, Sweet 1982), and availability of subsurface refugia (Dowling 1956, Rudolph 1978, Sweet 1982, Chippendale *et al.* 1993, Tumilson and Cline 1997). Another requirement for survival and reproduction is well oxygenated groundwater with a narrow temperature range (Davis *et al.* 2001, Bowles *et al.* 2006). Groundwater at the JPS sites flows from the Northern Segment of the Edwards Aquifer (Cole 1995), the Trinity Aquifer, and from local alluvial springs. Groundwater in the Jollyville Plateau was characterized using water level monitoring, groundwater tracing, water chemistry and tritium dating. Results imply that the Jollyville Plateau Edwards contains vadose zone conduits that transmit recharge water to springs and creeks with limited connection to the water table (Johns 2013).

In Travis County, most known JPS localities are found within the Bull Creek and Cypress Creek watersheds. The City of Austin, Travis County, and other cooperating agencies have established 13 long-term JPS population monitoring sites throughout Travis County. Most of the monitoring sites are located within the BCP.

Survey Sites & Locality Descriptions

Travis County Natural Resources staff regularly survey eight JPS locations (Figure 2). Four sites are monitored quarterly (since 2006): McDonald Well, SAS Upper and Lower Springs, and Kreschmarr Salamander Cave. Another four sites (R-Bar-B Spring, Concordia X and Y Springs, Kelly Hollow Spring) are searched annually and also during routine water quality monitoring visits.

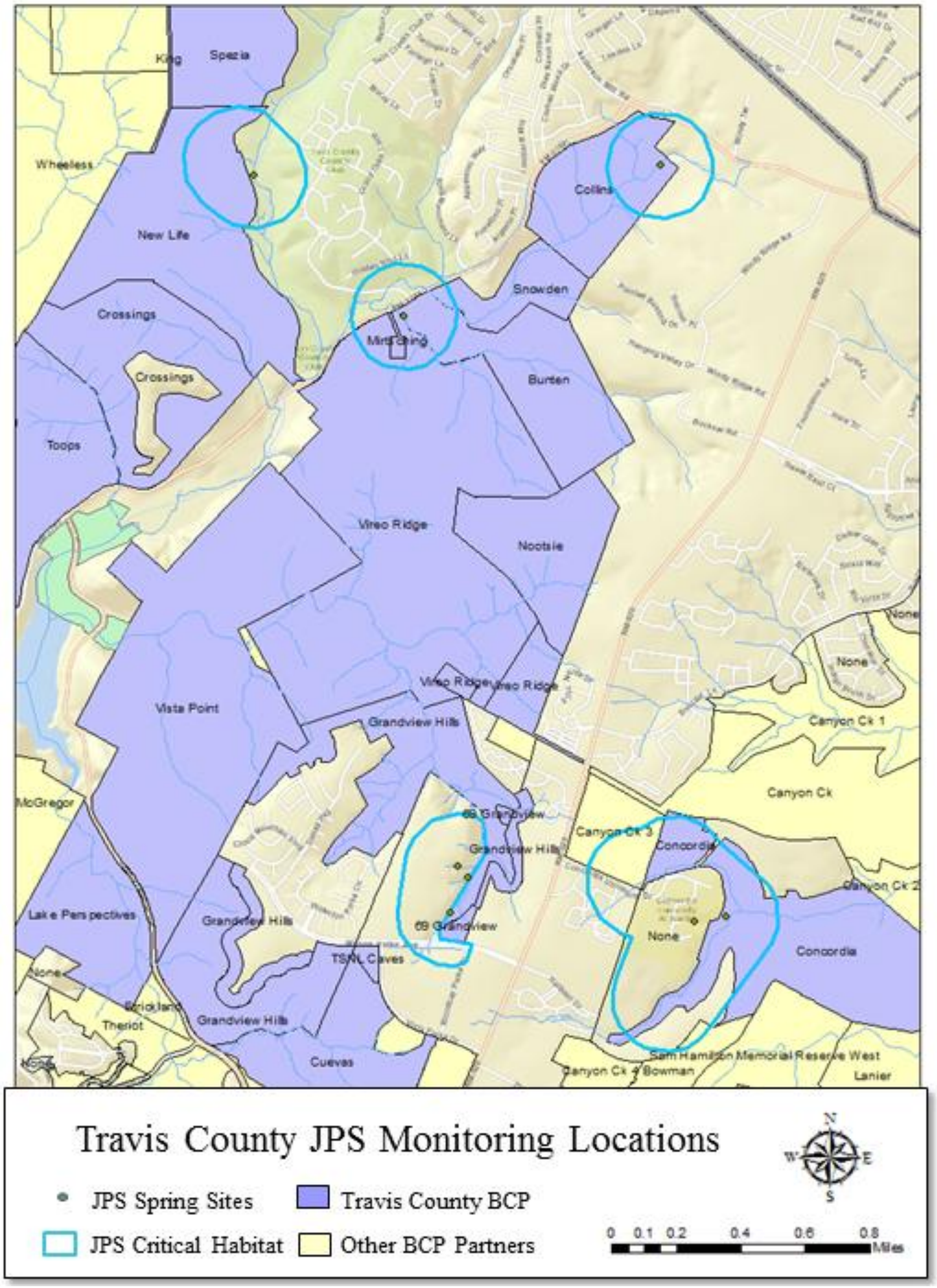

Figure 2. Eight locations where Travis County Natural Resources staff monitored the Jollyville Plateau salamander (*Eurycea tonkawae*) in FY13.

The SAS Canyon Springs (Upper and Lower) and Kretschmarr Salamander Cave sites are located on property owned by SAS Institute Inc., approximately 1 mile due north of the intersections of Highway 620 and FM 2222 (Figure 3). Travis County has an informal agreement with SAS Institute Inc. to access and monitor these JPS survey sites on a quarterly basis.

In 2008, eight springs in the Bull Creek watershed on the Concordia tract (Figure 3) were searched for JPS, with three locations confirmed. Of the three springs with JPS present, two are located on Travis County-managed preserve land (Spring Y and Spring 6) and the headwaters of the other is located on Concordia University property (Spring X) that is not part of the preserve.

In FY14, Travis County Natural Resource staff searched additional springs at the Concordia tract and observed salamanders at three sites. JPS were observed at two separate spring runs (Toad and Tardis Springs) in the southern tributary of Bull Creek and at six locations in a spring complex (Panther Springs) in the northern tributary.

In addition to new sites found at Concordia in FY14, JPS were observed in one spring (Lost Spring) on the Vireo Ridge tract. These locations were reported to USFWS staff and will be searched more thoroughly in FY15.

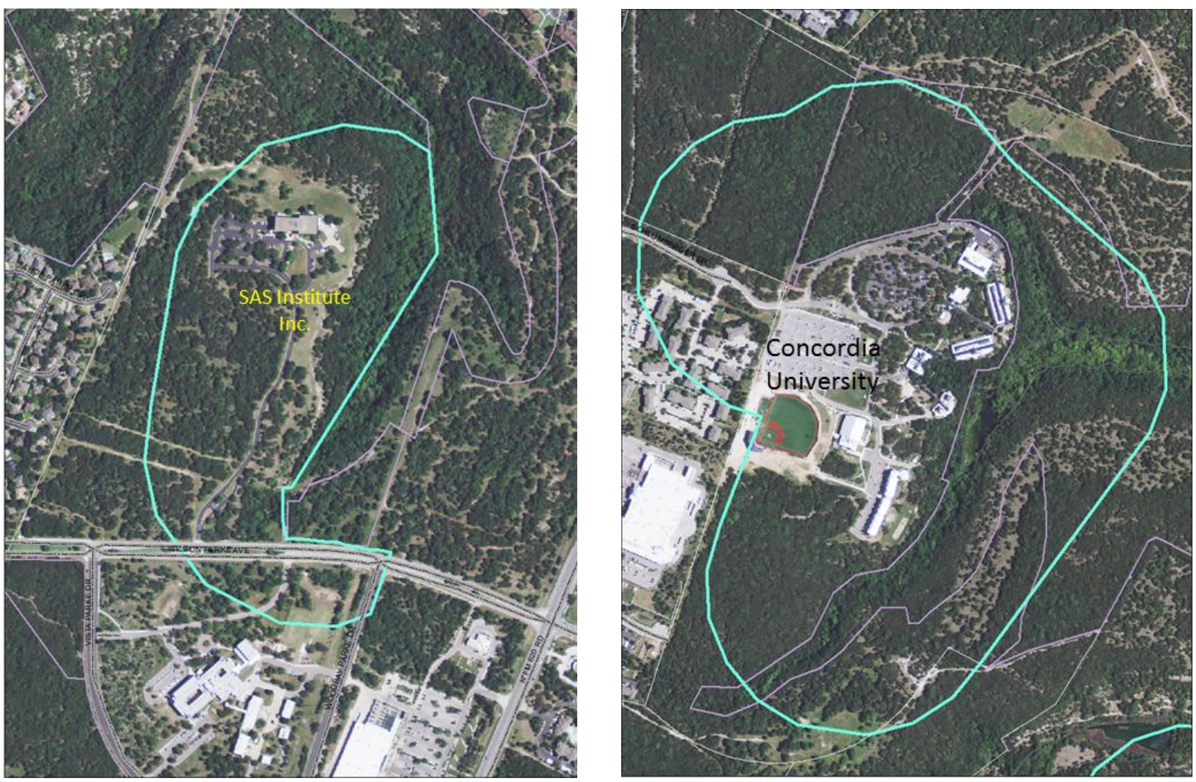

Figure 3. Map on the left shows Critical Habitat around the springs at SAS Canyon. The map on the right shows the Critical Habitat around JPS springs at Concordia.

McDonald Well spring discharges into an unnamed tributary approximately 500 m upstream of Cypress Creek. The BCP protects about half the critical habitat around this spring. It is located on Travis County BCP property called the Bunten tract, which is part of the larger 1,881-acre Jollyville Unit. McDonald well is located 13 miles northwest of downtown Austin near FM 2769 (Figure 4).

R-Bar-B spring is located in the Cypress Creek watershed on the New Life tract of the BCP. The 258-acre New Life tract, acquired by Travis County in 2010, is located off FM 2769 approximately 1.5 miles south of the intersection of Anderson Mill Road and FM 2769 (Figure 4). R-Bar-B Spring discharges 10 to 20 feet below the top of Glen Rose formation and forms the headwaters of Cypress Creek.

Figure 4. The map on the left shows the Critical Habitat around the JPS springs at R-bar-B. The map on the right shows Critical Habitat around the spring at McDonald Well.

Kelly Hollow Spring is located on Travis County BCP property called the Collins tract (Figure 5). The Collins tract (112.98 acres) is bounded by Anderson Mill Road to the north, private property to the east, FM 2769 to the west, and Travis County BCP property to the south. The spring discharges into an unnamed tributary that flows south approximately 2,500 m to its confluence with Cypress Creek.

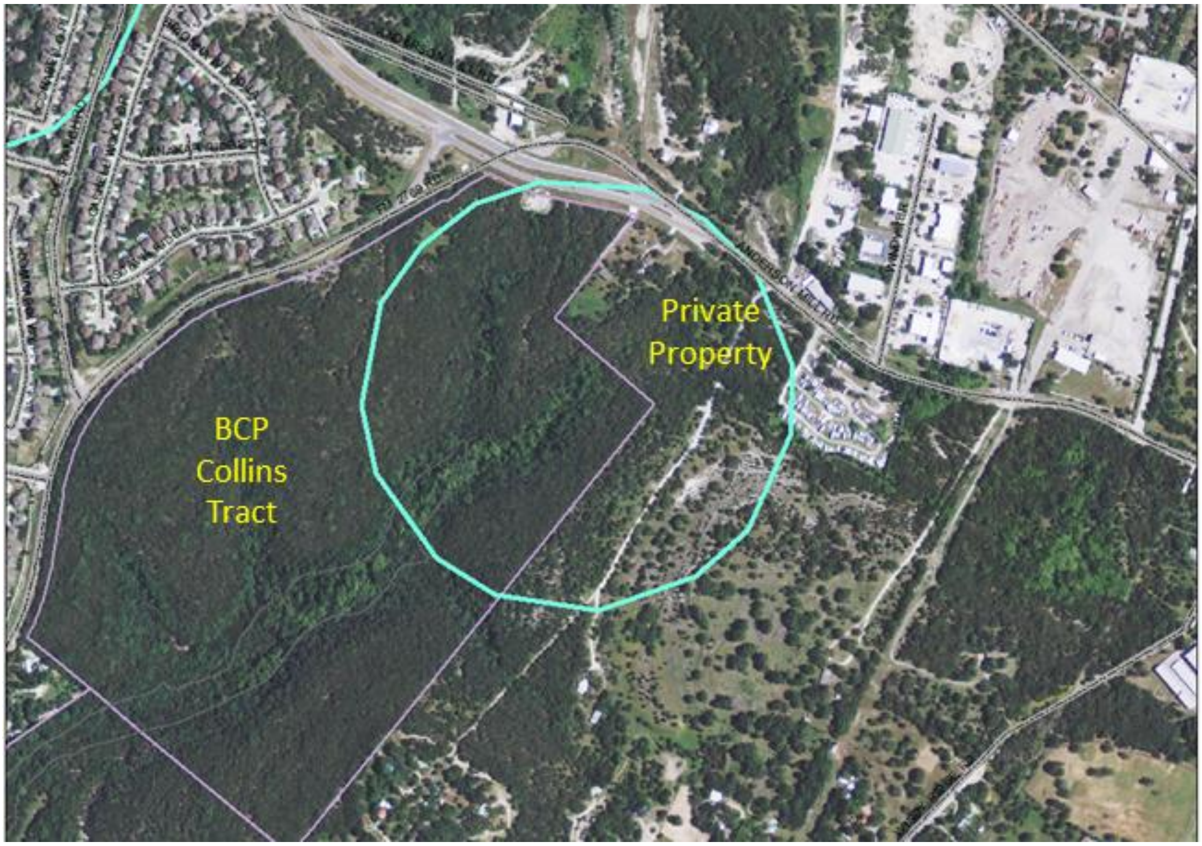

Figure 5. This photograph shows the Critical Habitat around Kelly Hollow Spring.

Methods

After Travis County received its U. S. Fish and Wildlife Permit to monitor JPS in May of 2014, surveys were scheduled. This report reflects surveys completed during the summer of FY14.

A surface count survey is conducted by searching under all cover objects on the surface of the stream (rocks, leaf litter, algae, woody debris, and aquatic macrophytes). Typically observers will start downstream and begin removing cover objects to create an open line perpendicular to the bank. Cover is searched moving upstream, counting only salamanders that move downstream of the observer (to avoid double-counts). Each salamander observed is recorded based on size class (Total length < one inch = small; one to two inches = medium; > two inches = large). Clear acrylic boxes are used to help reduce glare and view under water, especially in areas with turbulent flow. Surface counts are conducted under baseflow conditions (< one-half inch rainfall within the previous 24-hour period) to eliminate potential variable introduced by stormflow. The amount of search time is not constrained, but total search time is recorded for each site.

FY14 Jollyville Plateau Salamander Surveys

Travis County staff monitored six spring sites for JPS from May until July 2014 (Table 1).

Table 1. Results of JPS surveys at six BCP sites in the summer of 2014. Numbers of JPS detected for each of the three size classes are shown. Size classes are for total length.

Site	Date	<1 inch	1 - 2 inch	>1	Total
Kretschmarr Salamander Cave	7/7/2014	0	0	1	1
SAS Upper Spring	7/23/2014	0	4	1	5
SAS Lower Spring	6/24/2014	0	0	0	0
Concordia X Spring	7/8/2014	0	2	0	2
Kelly Hollow	7/12/2014	0	4	1	5
McDonald Well	5/2/2014	2	23	19	52*
McDonald Well	7/31/2014	0	2	0	2

*Fifty-two total JPS detected, but ten are of unknown size class.

Kretschmarr Salamander Cave

The spring inside Kretschmarr Salamander Cave was surveyed for JPS on July 7, 2014. One adult JPS was detected.

Figure 6. The spring run inside Kretschmarr Salamander Cave looking upstream where the stream emerges from the cave wall (left) and at plunge pool in the cave floor where the water flows underground (right).

Table 2. Water quality data from Kretschmarr Salamander Cave prior to JPS survey. For six month period measurement equals mean (standard deviation).

Time Period	DO Saturation (%)	Water Temp (°C)	DO (mg/L)	Specific Conductance (µS/cm)	pH	Nitrate (mg/L)
Survey Month	81.15	21.20	7.22	1174	6.90	2.0
Six Months Prior	72.35 (13.06)	20.26 (0.63)	6.87 (0.37)	1105 (70)	7.12 (0.24)	1.9 (0.5)

Upper SAS Spring

The upper spring pool in SAS Canyon Spring was surveyed on July 23, 2014 (Table 1). Despite significant rain (which reduced specific conductance) on July 17 and 18, 2014, flow decreased quickly at Upper SAS spring. Five JPS (one adult and four large juveniles) were observed.

Figure 7. Upper SAS spring outlet (left) and downstream (right) on July 23, 2014.

Table 3. Water quality data from SAS Upper Spring prior to JPS survey. For six month period measurement equals mean (standard deviation).

Time Period	DO Saturation (%)	Water Temp (°C)	DO (mg/L)	Specific Conductance (µS/cm)	pH	Nitrate (mg/L)	Standard Depth (mm)
Survey Month	56.57	21.46	5.01	448	6.95	0.3	485
Six Months Prior	61.66 (6.71)	19.07 (1.26)	5.71 (0.67)	621 (185)	7.06 (0.14)	0.4 (0.1)	156 (167)

Lower SAS Spring

The lower spring pool in SAS Canyon was surveyed for JPS on June 24, 2014. No JPS were detected.

Figure 8. Lower SAS spring outlet (left) and downstream (right) on June 24, 2014.

Table 4. Water quality data from SAS Lower Spring prior to JPS survey. For six month period measurement equals mean (standard deviation).

Time Period	DO Saturation (%)	Water Temp (°C)	DO (mg/L)	Specific Conductance (µS/cm)	pH	Nitrate (mg/L)	Standard Depth (mm)
Survey Month	72.79	22.86	6.29	506	7.32	0.3	305
Six Months Prior	43.71 (20.01)	16.98 (2.95)	4.15 (1.69)	629 (157)	7.27 (0.15)	0.3 (0)	226 (41)

<u>Concordia Spring X</u>

Concordia Spring X was surveyed on July 8, 2014. Two large juvenile JPS were observed.

Figure 9. Concordia Spring X upstream (left) and downstream (right) in 2014.

Table 5. Water quality data from Concordia Spring X prior to JPS survey. For six month period measurement equals mean (standard deviation).

Time Period	DO Saturation (%)	Water Temp (°C)	DO (mg/L)	Specific Conductance (µS/cm)	pH
Survey Month	53.76	21	4.8	670	7.75
Six Months Prior	56.33 (0.76)	21.33 (0.76)	6.55 (1.70)	683 (29)	7.44 (0.32)

Kelly Hollow Spring

Kelly Hollow Spring was searched for JPS on July 12, 2014. Five (four large juveniles and one adult) JPS were observed.

Figure 10. Kelly Hollow spring outlet (left) and downstream (right) in July 2014.

Table 6. Water quality data from Kelly Hollow prior to JPS survey. For six month period measurement equals mean (standard deviation).

Time Period	DO Saturation (%)	Water Temp (°C)	DO (mg/L)	Specific Conductance (µS/cm)	pH
Survey Month	59.35	19.55	5.44	793	6.82
Six Months Prior	9.19 (0.16)	19.41 (0.96)	5.30 (1.05)	781 (69)	7.15 (0.19)

McDonald Well

McDonald Well flowed intermittently in FY14, especially during the survey period of May to July (Table 7 and 8). JPS was detected in subsurface water or wet substrate on three occasions.

Table 7. Flow regime at McDonald Spring during FY14. During Low Flow, the springrun is too shallow to measure discharge.

Date	Flow (CFS)	Low Flow	Subsurface Flow	No Flow	Stranded JPS
9/20/2013				X	
10/18/2013	X (0.45)				
12/24/2013	X (0.55)				
1/29/2014	X (0.11)				
3/27/2014	X (0.07)				
5/2/2014			X		X
5/13/2014		X			
7/10/2014			X		X
7/22/2014		X			
7/31/2014			X		X
8/4/2014				X	
9/20/2014		X			
9/25/2014			X		

Table 8. Water quality data from McDonald Well from January to July 2014. For six month period measurement equals mean (standard deviation).

Time Period	DO Saturation (%)	Water Temp (°C)	DO (mg/L)	Specific Conductance (µS/cm)	pH	Nitrate (mg/L)	Flow Measure-ment (cfs)	Standard Depth (mm)
Jan to July 2014	56.69 (10.12)	17.57 (2.88)	5.42 (1.11)	740 (12)	7.24 (0.13)	1.1 (0.3)	0.09 (0.02)	134 (125)

On May 2, 2014 McDonald Well had stopped flowing on the surface (Figure 11). Fifty-two JPS were detected in the damp pebbles and gravel. Most were located under embedded larger rocks, which may have provided additional protection from predators and fluctuating environmental conditions. Ten JPS were in poor condition and were immediately preserved. All JPS collected were used for the USFWS diet and contaminants study (Scientific Research Permit 5-1-14-Diaz).

Figure 11. On the May 2, 2014 visit, McDonald Well did not have any surface flow. JPS were located under cobble and small bounders in the moist substrate.

McDonald began to flow again after over four inches of rain on May 12 to 13, 2014. It flowed until early July. By July 10, 2014, the water table was two-inches below the surface and red-imported fire ants covered the streambed. One large JPS was located under cobble (Figure 12).

Figure 12. The photographs on the left show the lack of surface flow on the July 10, 2014. The photographs on the right show the adult JPS found under cobble and depth of the water table.

After over four inches of rain on July 15 to 18, 2014, McDonald Well was flowing again. On July 22, 2014, one medium size (1-2-inch) JPS was observed in the well.

On July 31, 2014, the spring flow on the surface had ceased and a few pools remained. Two medium size (1-2-inch) JPS were detected in the well and springrun after a 33-minute search.

Water Quality

Travis County began routine water quality monitoring of basic parameters in January 2011 in cooperation with the Colorado River Watch Program (Lower Colorado River Authority). Over time more sites and monitors have been added (Table 9), with JPS sites given the highest priority. In FY14, Natural Resources partnered with Environmental Quality to secure a budget for laboratory analysis of water and sediment samples. Results of the first samples collected are presented in Tables 10 to 14.

Table 9. Water quality monitoring locations, start dates, and frequency.

Monitoring Location	Start Date	Frequency
Baker Spring	4/7/2014	Monthly
Bee Creek	6/22/2014	Monthly
Collins Grotto	12/9/2011	Monthly
Concordia X	7/19/2011 12/4/2014	Quarterly Monthly
Concordia Y	10/21/2011 12/4/2014	Quarterly Monthly
Cypress Creek at FM 2769	1/5/2011	Monthly
Kelly Hollow	12/9/2011	Monthly
Kretschmarr Salamander Cave	8/15/2011 12/16/2013	Every Other Month Monthly
McDonald Well	1/5/2011	Monthly (during flow)
Panther Springs	11/1/2014	Monthly
R-bar-B	1/12/2011	Monthly
SAS Upper	1/8/2011	Monthly
SAS Lower	6/12/2013 1/13/2014	Quarterly Monthly
Toad Spring	11/9/2014	Monthly

Table 10. Summary of mean (standard deviation) for five water quality parameters, discharge (where measurement possible), and depth data for eight JPS springs FY11 to FY14. See Table 9 for monitoring frequency for each FY.

Spring	DO Saturation (%)	Water Temp (°C)	DO (mg/L)	Specific Conductance (µS/cm)	pH	Nitrate (mg/L)	Discharge (cfs)	Standard Depth (mm)
Concordia Spring X FY11	53.76*	21*	4.8*	670*	7.75*	2*		
Concordia Spring X FY12	87.39 (13.92)	21.23 (0.87)	7.78 (1.34)	667 (6)	7.08 (0.21)	2.7 (1.1)		36.3 (0.6)
Concordia Spring X FY13	65.00 (9.24)	21.13 (0.75)	5.80 (0.90)	675 (17)	7.13 (0.19)	3.3 (1.1)		31.3 (6.2)
Concordia Spring X FY14	69.47 (16.96)	21.50 (0.70)	6.16 (1.59)	685 (24)	7.30 (0.38)	2.4 (1.3)		33.5 (3.9)
Concordia Spring Y FY11	23.74 (15.53)	22.0 (1.41)	2.10 (1.41)	610 (42)	7.38 (0.53)	1.0 (0)		
Concordia Spring Y FY12	78.00 (17.64)	20.17 (1.42)	7.10 (1.76)	620 (0)	7.26 (0.53)	2.7 (1.2)		51.0 (4.2)
Concordia Spring Y FY13	60.26 (11.46)	19.75 (2.75)	5.55 (1.32)	613 (10)	7.30 (0.42)	3.0 (1.4)		57.5 (4.9)
Concordia Spring Y FY14	65.14 (4.12)	20.00 (1.73)	5.93 (0.55)	640 (17)	7.36 (0.59)	1.6 (0.7)		42.0 (20.8)
Kelly Hollow FY12	57.55 (7.11)	19.36 (0.93)	5.30 (0.70)	794 (32)	7.15 (0.11)	2.0 (1.2)		164.4 (22.2)
Kelly Hollow FY13	52.04 (9.55)	20.26 (0.37)	4.71 (0.87)	794 (32)	7.03 (0.15)	1.6 (0.5)		99.3 (11.4)
Kelly Hollow FY14	61.95 (14.43)	19.6 (0.9)	5.68 (1.33)	780 (61)	7.11 (0.19)	0.8 (0.2)	0.10*	156.2
Kretschmarr Salamander Cave FY12	63.42 (15.78)	21.12 (1.85)	5.66 (1.45)	1170 (88)	7.10 (0.21)	2.2 (0.98)		
Kretschmarr Salamander Cave FY13	72.94 (8.07)	20.61 (0.42)	6.56 (0.72)	980 (79)	7.04 (0.14)	1.86 (0.38)		
Kretschmarr Salamander Cave FY14	72.16 (11.40)	20.50 (1.06)	6.71 (0.52)	1177 (160)	7.10 (0.21)	2.06 (0.60)		
McDonald Well FY11	44.39 (11.54)	17.87 (2.90)	4.19 (0.99)	718 (24)	7.24 (0.25)	1.0 (0)	0.92*	
McDonald Well FY12	49.25 (12.88)	18.00 (0.95)	4.66 (1.25)	730 (32)	7.17 (0.12)	1.67 (0.80)	0.373 (0.151)	
McDonald Well FY13	43.17 (14.13)	17.10 (6.27)	4.13 (1.20)	756 (25)	7.14 (0.21)	2.5 (1.0)	0.353 (0.426)	138.3 (20.3)
McDonald Well FY14	55.51 (8.95)	18.18 (2.30)	5.24 (0.96)	771 (35)	7.25 (0.09)	1.0 (0.4)	0.254 (0.203)	162.0 (87.32)
R-bar-B FY2011	68.39 (7.44)	20.28 (2.20)	6.21 (0.83)	657 (42)	7.12 (0.23)	2.3 (0.9)		191.2 (4.3)
R-bar-B FY2012	69.44 (8.92)	20.38 (1.34)	6.28 (0.92)	706 (42)	7.06 (0.17)	2.4 (1.1)	0.102 (0.061)	281.6 (79.4)
R-bar-B FY2013	71.43 (5.91)	20.86 (1.03)	6.40 (0.60)	729 (21)	7.06 (0.08)	3.3 (1.0)	0.064 (0.027)	203.4 (10.2)
R-bar-B FY2014	77.31 (5.90)	20.82 (0.86)	6.92 (0.52)	734 (22)	7.16 (0.18)	1.7 (0.7)	0.300 (0.395)	235.0 (31.3)
SAS Lower Spring FY11	35.74 (25.88)	19.87 (3.51)	3.38 (2.59)	696 (32)	7.31 (0.31)	1.0 (0)		69.0 (39.3)
SAS Lower Spring FY12	27.88 (15.31)	19.18 (3.43)	2.64 (1.53)	690 (63)	7.09 (0.23)	1.0 (0)	0.064 (0.053)	249.0 (64.61)
SAS Lower Spring FY13	27.16 (7.64)	19.22 (2.80)	2.53 (0.80)	656 (50)	7.00 (0.11)	1.14 (0.38)	0.04*	169.9 (52.4)
SAS Lower Spring FY14	45.68 (21.08)	17.98 (3.15)	4.32 (1.96)	619 (139)	7.31 (0.31)	0.3 (0.1)	0.071*	248.4 (88.5)
SAS Upper Spring FY12	43.33 (6.24)	21.67 (0.59)	3.83 (0.57)	662 (58)	6.94 (0.12)	1.5 (0.7)		460*
SAS Upper Spring FY13	42.18 (21.72)	20.32 (1.54)	4.63 (0.92)	661 (42)	6.97 (0.07)	1.2 (0.4)		54.7 (43.8)
SAS Upper Spring FY14	58.81 (10.62)	19.45 (1.47)	5.42 (1.08)	622 (160)	7.05 (0.19)	0.4 (0.2)		174.4 (146.1)

*number is based on single measurement (not mean)

Table 11. Results of laboratory analysis of water samples (LCRA Environmental Laboratory Services). Samples collected 9/18/2014* (storm flow conditions) and 9/24/2014 (normal to high flow conditions).

Site	BCP Tract	Chloride (mg/L)	Sulfate (mg/L)	NH_3 as N (mg/L)	Kjeldahl N (mg/L)	Total PO_4 as P (mg/L)	TDS (mg/L)	TSS (mg/L)	Alkalinity (mg/L)	E. Coli (MPN)	Chlorophyll-a (µg/L)	Pheophytin (µg/L)	Nitrate/Nitrite (mg/L)
Bullick Hollow	Lake Perspectives	30.50	42.50	<0.0200	0.111	<0.0200	352.0	<1.01	236	12.0	<0.500	<0.500	0.0859
Collins Grotto*	Collins	5.17	22.20	<0.0200	0.407	0.0269	198.0	1.70	151	1300	<0.500	<0.500	0.337
Connors Creek*	Greenshores	15.30	9.62	<0.0200	0.614	0.0206	193.0	3.67	108	4840	<0.500	<0.500	1.22
Cypress Creek at FM2769	downstream of New Life	40.50	38.10	0.1760	0.585	0.0242	402.0	4.28	257	153	9.99	3.96	1.00
Honey Creek	Chandler	50.30	44.40	<0.0200	0.140	<0.0200	394.0	<1.04	237	42	<0.500	<0.500	0.504
Kelly Hollow*	Collins	14.60	32.90	<0.0200	0.166	<0.0200	359.0	3.00	288	167	<0.500	<0.500	0.573
Kretschmarr Salamander Cave*	SAS Institute (not BCP)	68.90	67.70	<0.0200	0.389	0.0329	465.0	5.90	246	1120	<0.500	<0.500	1.1
Lost Spring	Vireo Ridge	34.90	35.30	<0.0200	0.133	<0.0200	409.0	2.60	273	88.2	<0.500	<0.500	0.0811
Lower Ribelin Spring	Sam Hamilton	14.10	13.50	<0.0200	<0.100	<0.0200	333.0	1.10	276	41.4	<1.00	<1.00	0.241
McDonald Well*	Bunten	41.70	38.00	<0.0200	0.306	0.0231	431.0	<1.00	286	1550	<0.500	<0.500	1.36
R-bar-B*	New Life	30.30	34.00	<0.0200	0.124	<0.0200	403.0	1.70	278	345	<1.00	<1.00	1.89
SAS Lower Spring*	SAS Institute (not BCP)	9.01	10.60	<0.0200	0.199	<0.0200	224.0	<1.00	190	260	<0.500	<0.500	0.278
SAS Upper Spring*	SAS Institute (not BCP)	8.63	9.92	<0.0200	0.238	<0.0200	240.0	1.30	203	649	<0.500	<0.500	0.469
Spring 6*	Concordia	1.47	1.85	<0.0200	0.278	0.0392	107.0	3.16	85.5	2420	<0.500	<0.500	0.158
Spring X*	Concordia	7.73	8.68	<0.0200	0.352	0.0319	257.0	21.70	244	980	<0.500	<0.500	1.11
Spring Y*	Concordia	18.10	18.00	<0.0200	0.262	<0.0200	318.0	14.30	254	168	<0.500	<0.500	1.37
Steiner Ranch J-canyon	Steiner Ranch	121.00	107.00	<0.0200	0.273	0.0233	666.0	1.33	299	135	<0.500	<0.500	1.17
Talus Springs	Grandview Hills	110.00	114.00	<0.0200	0.333	0.0221	726.0	24.70	354	32.3	<0.500	<0.500	3.89
Tardis*	Concordia	1.57	1.87	<0.0200	0.285	0.0319	95.0	4.04	84.1	2420	<0.500	<0.500	0.165
Toad Spring*	Concordia	1.35	1.17	<0.0200	0.316	0.0525	61.0	5.40	52.9	>2420	<0.500	<0.500	0.138
Unnamed Creek*	Cuevas	11.30	40.50	<0.0200	0.604	0.0392	245.0	12.0	144	3470	<0.500	<0.500	0.173
Upper Panther Spring	Concordia	18.50	15.60	<0.0200	<0.100	<0.0200	383.0	1.48	295	5.2	1.02	0.536	1.75

Table 12. Results of laboratory analysis of sediment samples (DHL Analytical). Sample collected from Cypress Creek at FM 2769 (downstream of R-bar-B spring and Twin Creek Golf Course) on 9/16/2014.

TestNo	Analyte	FinalVal (mg/Kg - dry)	Qual	MDL	PQL	CAS
D2216	Percent Moisture	35.4		0	0	GSMOIS
SW6020A	Arsenic	2.12		0.523	1.05	7440-38-2
SW6020A	Barium	49.9		0.523	2.09	7440-39-3
SW6020A	Cadmium	0.140	J	0.105	0.314	7440-43-9
SW6020A	Chromium	8.48		0.523	2.09	7440-47-3
SW6020A	Copper	3.31		0.523	2.09	7440-50-8
SW6020A	Lead	7.35		0.105	0.314	7439-92-1
SW6020A	Zinc	17.5		1.05	2.61	7440-66-6
SW7471B	Mercury	<0.0111		0.0111	0.0279	7439-97-6
SW8082A	Aroclor 1016	<0.0733		0.0733	0.147	12674-11-2
SW8082A	Aroclor 1221	<0.0733		0.0733	0.147	11104-28-2
SW8082A	Aroclor 1232	<0.0733		0.0733	0.147	11141-16-5
SW8082A	Aroclor 1242	<0.0733		0.0733	0.147	53469-21-9
SW8082A	Aroclor 1248	<0.0733		0.0733	0.147	12672-29-6
SW8082A	Aroclor 1254	<0.0733		0.0733	0.147	11097-69-1
SW8082A	Aroclor 1260	<0.0733		0.0733	0.147	11096-82-5
SW8270D	1,2,5,6-Dibenzanthracene	<0.015		0.015	0.0398	53-70-3
SW8270D	Acenaphthene	<0.015		0.015	0.0398	83-32-9
SW8270D	Acenaphthylene	<0.015		0.015	0.0398	208-96-8
SW8270D	Aldrin	<0.00199		0.00199	0.00598	309-00-2
SW8270D	alpha-BHC	<0.00199		0.00199	0.00598	319-84-6
SW8270D	alpha-Chlordane	<0.00199		0.00199	0.00598	5103-71-9
SW8270D	Anthracene	<0.015		0.015	0.0398	120-12-7
SW8270D	Benzo[a]pyrene	0.0299	J	0.015	0.0398	50-32-8
SW8270D	Benzo[b]fluoranthene	<0.015		0.015	0.0398	205-99-2
SW8270D	Benzo[g,h,i]perylene	<0.015		0.015	0.0398	191-24-2
SW8270D	Benzo[k]fluoranthene	<0.015		0.015	0.0398	207-08-9
SW8270D	Chlordane	<0.00199		0.00199	0.00598	57-74-9
SW8270D	Chrysene	<0.015		0.015	0.0398	218-01-9
SW8270D	Demeton, Total	<0.00199		0.00199	0.00598	8065-48-3
SW8270D	Diazinon	0.00462	JN	0.00199	0.00598	333-41-5
SW8270D	Dieldrin	<0.00199		0.00199	0.00598	60-57-1
SW8270D	Endrin	<0.00199		0.00199	0.00598	72-20-8
SW8270D	Fluoranthene	<0.015		0.015	0.0398	206-44-0
SW8270D	Fluorene	<0.015		0.015	0.0398	86-73-7
SW8270D	gamma-Chlordane	<0.00199		0.00199	0.00598	5566-34-7
SW8270D	Guthion	<0.00199		0.00199	0.00598	86-50-0
SW8270D	Indeno[1,2,3-cd]pyrene	<0.015		0.015	0.0398	193-39-5
SW8270D	Methyl parathion	<0.00199		0.00199	0.00598	298-00-0
SW8270D	Naphthalene	<0.015		0.015	0.0398	91-20-3
SW8270D	Pentachlorophenol	<0.015		0.015	0.0398	87-86-5
SW8270D	Phenanthrene	<0.015		0.015	0.0398	85-01-8
SW8270D	Pyrene	<0.015		0.015	0.0398	129-00-0
SW8270D	Toxaphene	<0.0798		0.0798	0.249	8001-35-2
SW8321B	2,4,5-T	<0.0149		0.0149	0.0595	93-76-5
SW8321B	Silvex	<0.0149		0.0149	0.0595	93-72-1
SW8321B	2,4-D	<0.0149		0.0149	0.0595	94-75-7
SW8321B	Dicamba	<0.149		0.149	0.595	1918-00-9
SW8321B	Dinoseb	<0.0149		0.0149	0.0595	88-85-7

Table 13. Results of laboratory analysis of sediment samples (DHL Analytical). Sample collected from Lower SAS Spring on 9/23/2014.

TestNo	Analyte	FinalVal (mg/Kg-dry)	Qual	MDL	PQL	CAS
D2216	Percent Moisture	44.6		0	0	GSMOIS
SW6020A	Arsenic	7.68		0.705	1.41	7440-38-2
SW6020A	Barium	90.0		0.705	2.82	7440-39-3
SW6020A	Cadmium	0.442		0.141	0.423	7440-43-9
SW6020A	Chromium	28.2		0.705	2.82	7440-47-3
SW6020A	Copper	14.3		0.705	2.82	7440-50-8
SW6020A	Lead	18.8		0.141	0.423	7439-92-1
SW6020A	Zinc	60.2		1.41	3.53	7440-66-6
SW7471B	Mercury	0.0484		0.015	0.0376	7439-97-6
SW8082A	Aroclor 1016	<0.0844		0.0844	0.169	12674-11-2
SW8082A	Aroclor 1221	<0.0844		0.0844	0.169	11104-28-2
SW8082A	Aroclor 1232	<0.0844		0.0844	0.169	11141-16-5
SW8082A	Aroclor 1242	<0.0844		0.0844	0.169	53469-21-9
SW8082A	Aroclor 1248	<0.0844		0.0844	0.169	12672-29-6
SW8082A	Aroclor 1254	<0.0844		0.0844	0.169	11097-69-1
SW8082A	Aroclor 1260	<0.0844		0.0844	0.169	11096-82-5
SW8270D	1,2,5,6-Dibenzanthracene	0.0270	J	0.0176	0.0469	53-70-3
SW8270D	Acenaphthene	<0.0176		0.0176	0.0469	83-32-9
SW8270D	Acenaphthylene	<0.0176		0.0176	0.0469	208-96-8
SW8270D	Aldrin	<0.00235		0.00235	0.00705	309-00-2
SW8270D	alpha-BHC	<0.00235		0.00235	0.00705	319-84-6
SW8270D	alpha-Chlordane	<0.00235		0.00235	0.00705	5103-71-9
SW8270D	Anthracene	<0.0176		0.0176	0.0469	120-12-7
SW8270D	Benzo[a]pyrene	0.101		0.0176	0.0469	50-32-8
SW8270D	Benzo[b]fluoranthene	0.129		0.0176	0.0469	205-99-2
SW8270D	Benzo[g,h,i]perylene	0.0835		0.0176	0.0469	191-24-2
SW8270D	Benzo[k]fluoranthene	0.125		0.0176	0.0469	207-08-9
SW8270D	Chlordane	<0.00235		0.00235	0.00705	57-74-9
SW8270D	Chrysene	0.138		0.0176	0.0469	218-01-9
SW8270D	Demeton, Total	<0.00235		0.00235	0.00705	8065-48-3
SW8270D	Diazinon	<0.00235	N	0.00235	0.00705	333-41-5
SW8270D	Dieldrin	<0.00235		0.00235	0.00705	60-57-1
SW8270D	Endrin	<0.00235		0.00235	0.00705	72-20-8
SW8270D	Fluoranthene	0.170		0.0176	0.0469	206-44-0
SW8270D	Fluorene	<0.0176		0.0176	0.0469	86-73-7
SW8270D	gamma-Chlordane	<0.00235		0.00235	0.00705	5566-34-7
SW8270D	Guthion	<0.00235		0.00235	0.00705	86-50-0
SW8270D	Indeno[1,2,3-cd]pyrene	0.0741		0.0176	0.0469	193-39-5
SW8270D	Methyl parathion	<0.00235		0.00235	0.00705	298-00-0
SW8270D	Naphthalene	<0.0176		0.0176	0.0469	91-20-3
SW8270D	Pentachlorophenol	<0.0176		0.0176	0.0469	87-86-5
SW8270D	Phenanthrene	0.0329	J	0.0176	0.0469	85-01-8
SW8270D	Pyrene	0.143		0.0176	0.0469	129-00-0
SW8270D	Toxaphene	<0.094		0.094	0.294	8001-35-2
SW8321B	Silvex	<0.0173		0.0173	0.0693	93-72-1
SW8321B	2,4,5-T	<0.0173		0.0173	0.0693	93-76-5
SW8321B	2,4-D	<0.0173		0.0173	0.0693	94-75-7
SW8321B	Dicamba	<0.173		0.173	0.693	1918-00-9
SW8321B	Dinoseb	<0.0173		0.0173	0.0693	88-85-7

Table 14. Results of laboratory analysis of sediment samples (DHL Analytical). Sample collected from J-canyon in Steiner Ranch on 9/22/2014.

TestNo	Analyte	FinalVal (mg/Kg-dry)	Qual	MDL	PQL	CAS
D2216	Percent Moisture	22.7		0	0	GSMOIS
SW6020A	Arsenic	3.65		0.563	1.13	7440-38-2
SW6020A	Barium	23.9		0.563	2.25	7440-39-3
SW6020A	Cadmium	0.139	J	0.113	0.338	7440-43-9
SW6020A	Chromium	5.45		0.563	2.25	7440-47-3
SW6020A	Copper	3.02		0.563	2.25	7440-50-8
SW6020A	Lead	6.51		0.113	0.338	7439-92-1
SW6020A	Zinc	13.6		1.13	2.81	7440-66-6
SW7471B	Mercury	<0.0108		0.0108	0.027	7439-97-6
SW8082A	Aroclor 1016	<0.0639		0.0639	0.128	12674-11-2
SW8082A	Aroclor 1221	<0.0639		0.0639	0.128	11104-28-2
SW8082A	Aroclor 1232	<0.0639		0.0639	0.128	11141-16-5
SW8082A	Aroclor 1242	<0.0639		0.0639	0.128	53469-21-9
SW8082A	Aroclor 1248	<0.0639		0.0639	0.128	12672-29-6
SW8082A	Aroclor 1254	<0.0639		0.0639	0.128	11097-69-1
SW8082A	Aroclor 1260	<0.0639		0.0639	0.128	11096-82-5
SW8270D	1,2,5,6-Dibenzanthracene	<0.0124		0.0124	0.033	53-70-3
SW8270D	Acenaphthene	<0.0124		0.0124	0.033	83-32-9
SW8270D	Acenaphthylene	<0.0124		0.0124	0.033	208-96-8
SW8270D	Aldrin	<0.00165		0.00165	0.00496	309-00-2
SW8270D	alpha-BHC	<0.00165		0.00165	0.00496	319-84-6
SW8270D	alpha-Chlordane	<0.00165		0.00165	0.00496	5103-71-9
SW8270D	Anthracene	<0.0124		0.0124	0.033	120-12-7
SW8270D	Benzo[a]pyrene	<0.0124		0.0124	0.033	50-32-8
SW8270D	Benzo[b]fluoranthene	<0.0124		0.0124	0.033	205-99-2
SW8270D	Benzo[g,h,i]perylene	<0.0124		0.0124	0.033	191-24-2
SW8270D	Benzo[k]fluoranthene	<0.0124		0.0124	0.033	207-08-9
SW8270D	Chlordane	<0.00165		0.00165	0.00496	57-74-9
SW8270D	Chrysene	<0.0124		0.0124	0.033	218-01-9
SW8270D	Demeton, Total	<0.00165		0.00165	0.00496	8065-48-3
SW8270D	Diazinon	<0.00165	N	0.00165	0.00496	333-41-5
SW8270D	Dieldrin	<0.00165		0.00165	0.00496	60-57-1
SW8270D	Endrin	<0.00165		0.00165	0.00496	72-20-8
SW8270D	Fluoranthene	<0.0124		0.0124	0.033	206-44-0
SW8270D	Fluorene	<0.0124		0.0124	0.033	86-73-7
SW8270D	gamma-Chlordane	<0.00165		0.00165	0.00496	5566-34-7
SW8270D	Guthion	<0.00165		0.00165	0.00496	86-50-0
SW8270D	Indeno[1,2,3-cd]pyrene	<0.0124		0.0124	0.033	193-39-5
SW8270D	Methyl parathion	<0.00165		0.00165	0.00496	298-00-0
SW8270D	Naphthalene	<0.0124		0.0124	0.033	91-20-3
SW8270D	Pentachlorophenol	<0.0124		0.0124	0.033	87-86-5
SW8270D	Phenanthrene	<0.0124		0.0124	0.033	85-01-8
SW8270D	Pyrene	<0.0124		0.0124	0.033	129-00-0
SW8270D	Toxaphene	<0.0662		0.0662	0.207	8001-35-2
SW8321B	Silvex	<0.0123		0.0123	0.0491	93-72-1
SW8321B	2,4,5-T	<0.0123		0.0123	0.0491	93-76-5
SW8321B	2,4-D	<0.0123		0.0123	0.0491	94-75-7
SW8321B	Dicamba	<0.123		0.123	0.491	1918-00-9
SW8321B	Dinoseb	<0.0123		0.0123	0.0491	88-85-7

Scientific Research Permits

In FY14, three Scientific Research Permits were issued for research related to JPS on TC-managed BCP lands.

One permit was issued to Nathan Bendik, an Environmental Scientist with the City of Austin, for mark-recapture and occupancy studies of JPS. The objectives of the mark-recapture study are to collect information about the life history and population dynamics of JPS. This information included individual growth rates, population size trends, survival, and temporary emigration estimates. This information will be used to better understand the ecology of the species and how this species responds to environmental fluctuations. The goal of the occupancy study is to understand how occupancy of JPS changes in different habitats in rural and urban streams. Three surveys are conducted every period (up to four periods a year) along evenly spaced 10 m transects in a tributaries of Bull Creek on the Concordia tract (See Appendix P5).

A permit was issued to Peter Diaz from the U.S. Fish and Wildlife Service to include Upper and Lower Ribelin springs (Sam Hamilton tract), R-bar-B spring (New Life tract), and McDonald spring (Bunten tract) the study of central Texas Eurycea, water quality, and urbanization. JPS and crayfish tissue (up to 4 g) was collected for contaminant analysis. Also, passive samplers were deployed to collect contaminant data. Aquatic invertebrates were collected to determine their relative abundance and community structure at each site. (See Appendix P9).

A permit was issued to Amanda Aurora, Senior Scientist/Project Manager with SWCA Environmental Consultants to assess habitat for JPS at the Ribelin and Sam Hamilton East tracts. Habitat assessments were conducted for Leander Independent School District (LISD) to support their application for an incidental take permit from the U.S. Fish and Wildlife Service. LISD is seeking a take permit to construct a new roadway along an infrastructure corridor in the preserve to serve the Vandegrift High School and Four Points Middle school campuses (See Appendix P17).

Threats

Amphibians are sensitive indicators of environmental degradation (Barinaga 1990, Blaustein et al. 1994, Hartwell and Ollivier 1998). Amphibians with restricted ranges, in or near expanding metro areas, face great risk of extinction. Of the thirteen *Eurycea* salamanders in central Texas, seven are threatened by or completely surrounded by development. Most known localities are at risk from urbanization due to their localized recharge areas. (Chippendale *et al.* 2000, Chippendale and Price 2005, USFWS 2012). Prior research has shown that salamander densities are reduced in urbanized stream catchments (Orser and Shure 1972, Willson and Dorcas 2003). Urbanization can cause changes to natural flow regime and degradation of surface and groundwater. These changes to habitat quality may be the largest threat facing the JPS and must be considered in conservation efforts (Bowles *et al.* 2006).

The City of Austin's population has grown 192% from 1970 to 2007 (COA 2007). Bowles *et al.* (2006) found lower JPS density in developed tributaries compared to springs in undeveloped watersheds. Developed tributaries had higher concentrations of chloride, magnesium, nitrate-nitrogen, potassium, sodium, and sulfate (Bowles *et al.* 2006). Four of nine JPS sites monitored by the City of Austin from 1996 to 2007 showed statistically significant declines in salamander abundance over ten years (O'Donnell *et al.* 2006). Analysis of count data from 1996 to 2011 reveal that JPS populations declined in areas with the largest increases in residential development over a 15-year period and furthermore, that densities of the JPS are negatively correlated with residential development across its range (Bendik *et al*. 2014).

Future Conservation Efforts

To address the conservation of the JPS, Travis County will continue manage and acquire land to protect endangered species, which will benefit this species and water quality. All springs within Travis County BCP tracts will be protected and if found to host JPS, will be managed to protect this species. Travis County will also collaborate in research efforts to elucidate many of the unknowns in regard to JPS life history, habitat preferences, potential threats, and the mechanics of the northern segment of the Edwards Aquifer. Also, Travis County will continue to contribute long-term monitoring by performing regular JPS surveys and water quality monitoring at known JPS sites and other BCP sites where appropriate. Staff will explore other preserve springs, creeks, and tributaries for populations of JPS and document any discoveries in annual reports submitted to USFWS. After discovery of additional populations, staff will return on a regular basis to verify JPS presence at these sites.

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